REMARKS

Applicants appreciate the thoroughness with which the Examiner has examined the above-identified application. Reconsideration is requested in view of the amendments above and the remarks below.

Claims1, 3, 4, 5, 8, 11, 12, 13 and 16 have been amended.

Claims 6, 7, 10, 17, 18 and 19 have been canceled.

Claims 21-24 have been added.

Support for the amendments to the above claims and for the above new claims can be found in canceled claims 6, 7, 10, 17, 18 and 19, and in the specification at paragraphs 0047, 0058, 0059 and 0065.

No new matter has been added.

35 USC 103 Rejections

In the above office action, the Examiner has rejected claims 1-20 under 35 USC 103(a) as being unpatentable over U.S. Patent No. 6,472,107 to Chan in view of U.S. Patent No. 5,948,570 to Kornblit et al., as well as being rejected as unpatentable over Kornblit in view of Chan. Applicant respectfully disagrees with both rejections.

To demonstrate the differences between Applicant's claimed invention and the prior art it may be helpful to first set forth Applicant's invention.

As recited in amended claims 1-5, the invention is directed to a photomask material that includes a mask blank in the form of a transparent substrate. Directly over and

contacting the transparent substrate is an opaque layer. Directly over and contacting this opaque layer is a metal layer, and directly over and contacting the metal layer is a resist layer having a thickness ranging from about 1000 Å to about 2000 Å to provide for improved achievable minimum resolution on the photomask. In this photomask, the transparent substrate is made of a material selected from the group consisting quartz, glass, silica glass, polysilicate glass, soda glass, and thin membrane materials made of silicon, SiN, SiC and diamond. Also, the chrome-based material may be chrome or Cr:O:N, while the metal layer may comprise tungsten, tungsten-silicon, tantalum or tantalum-silicon having a thickness ranging from about 20 Å to about 600 Å. Optionally, an adhesion promoting layer, such as Hexa-methyl-disilizane, may reside between the metal layer and the resist layer as is recited in new claims 21 and 22.

Amended claims 8-12 clarify that the present invention is directed to a photomask material that includes a transparent glass substrate, a chrome-based layer directly over and contacting the transparent glass substrate, a copper layer directly over and contacting the chrome-based layer followed by a resist layer directly over and contacting the copper layer. The chrome-based layer may be chrome or Cr:O:N deposited to a thickness ranging from about 700 Å to about 1200 Å, while the copper layer has a thickness ranging from about 100 Å to 600 Å and the resist layer has a thickness ranging from about 1000 Å to 2000 Å to provide for improved achievable minimum resolution on the photomask. Optionally, an adhesion promoting layer may be between the metal layer and the resist layer as is recited in new claim 23.

Claims 13-16 and 20, as amended, recite that the invention is also directed to a method of manufacturing a photomask by providing a transparent substrate, depositing an opaque layer (chrome or Cr:O:N of about 700 Å to 1200 Å) directly over and contacting the transparent substrate, followed by a metal layer (tantalum, tantalum-silicon or copper) directly over and contacting the opaque layer to a thickness ranging from about 20 Å to about 600 Å. A resist layer is then deposited over the metal layer to a thickness ranging from about 1000 Å to 2000 Å. The resist layer is imaged to form a resist mask pattern and expose portions of the metal layer, and then the exposed portions of the metal layer are etched using a first etchant that etches the metal layer faster than the underlying opaque layer to create a metal layer image. This image is transferred into the underlying exposed portions of the opaque layer using a second etchant that etches the opaque layer faster than the metal layer to form a photomask in the opaque layer. It is the thickness of the resist layer that provides for improved achievable minimum resolution, image quality and critical dimension uniformity of the photomask. Optionally, an adhesion promoting layer is deposited between the metal layer and the resist layer as is recited in new claim 24.

In the above office action, the Examiner takes the position, with respect to the rejection of Chan in view of Kornblit, that it would have been obvious to one of ordinary skill in the art at the time the invention was made to coat a resist to an optimum thickness, based on the material and exposure parameters used as the range suggested by Kornblit 200-500 micron (col. 5, lines 38-42) would assure success in forming Chan's mask using similar resist and exposure methods. Similarly, with respect to the rejection of Kornblit in

view of Chan, the Examiner takes the position that a skilled artisan, at the time the invention was made would have readily realized the instant invention by adjusting the metal and Cr thickness values as suggested by Chan in Kornblit's process. The motivation for this arises from the fact that these values are conventional and known in the art (Chan: col. 1; 42-44); these tried and typical ranges (Chan: 3;63-4;13) provide a reasonable expectation of success in forming the mask with superior control of the critical dimensions (Chan:5;59-64).

Applicant respectfully disagrees with both of the Examiners rejections as it is applicant's position that both Kornblit et al. and Chan are directed to conventional prior art references at which the application is aimed at overcoming.

As disclosed in the present specification at paragraphs 0005 to 0012, the present invention is directed to overcoming the problems with conventional photomasks that comprise a transparent base, with a metal film (chrome) thereon followed by a photoresist over the metal film, which are plagued with problems as is discussed therein.

The Kornblit et al. patent is a typical example of the prior art discussed in applicant's specification at paragraphs 0005 to 0012. It discloses a transparent substrate 10 having thereon a metallic (chrome) layer 11 with a polymer resist layer 12 "of about 0.2 to 1 micrometers" (2,000 Å to 10,000 Å) there over. (Figs. 1, 3, col. 2, lines 45-48, col. 3, lines 40-50 and 65-67.) The resist layer 12 is patterned, the pattern transferred into the

metallic layer 11 to form a patterned metallic layer 41, and then resist may then be removed. (Col. 3, line 68 to col. 4, line 11 and 51-55 and Fig. 3.) Fig. 4 of Kornblit shows an earlier stage of Fig. 5 wherein the "chrome layer 41 has been patterned in the same manner as described above, except that it now is located upon the top surface of a uniformly thick tungsten layer 55." (Col. 4, lines 60-64.) It is submitted that the photomask of Kornblit et al. will be plagued with problems as discussed in the present application at paragraphs 0005 to 0012.

In overcoming the problems with the photomask of Kornblit et al., the present invention is directed to a photomask that includes a transparent substrate, with an opaque layer (chrome-based layer) thereover, followed by a metal layer, and then a resist layer having a thickness from about 1000 Å to about 2000 Å. Applicants are claiming a method of making and a photomask having in sequence an opaque chrome layer, a metal layer, a resist layer of a thickness ranging from about 1,000 Å to 2,000 Å which is not taught by the prior art as necessary to achieve the results obtained by applicants. The Kornblit patent discloses a resist layer thickness of 2,000 Å to 10,000 Å, which is a difference in kind and not degree. That is, applicant submits that the resist thickness from about 1000 Å to about 2000 Å directly over the metal layer of the present invention is a difference in kind that is critical to the properties of the present invention such that the present invention is not obvious over Kornblit et al. in view of Chan.

In overcoming the problems with the photomask of Kornblit et al., the present invention is directed to a photomask that includes a transparent substrate, with an opaque layer (chrome-based layer) thereover, followed by a metal layer, and then a resist layer having a thickness from about 1000 Å to about 2000 Å. Applicants are claiming a method of making and a photomask having in sequence an opaque chrome layer, a metal layer, a resist layer of a thickness ranging from about 1,000 Å to 2,000 Å which is not taught by the prior art as necessary to achieve the results obtained by applicants. The Kornblit patent discloses a resist layer thickness of 2,000 Å to 10,000 Å, which is a difference in kind and not degree. It is established case law that proportions must be critical, i.e., they must produce a difference in kind rather than degree and if the proportions are critical to the properties of the novel product, they can render the product patentable even though the percentages fall within the broader ranges of the prior art. *Becket v. Coe 38 USPQ 26 (CADC 1938); In re Becket et al. 33 USPQ 33 (CCPA 1937).*

That is, applicant submits that the present resist thickness from about 1000 Å to about 2000 Å directly over the metal layer of the present invention is a difference in kind that is critical to the properties of the present invention as supported in the specification at least at paragraphs 0059 and 0065.

The Chan patent does not overcome the deficiencies of Kornblit, nor does Kornblit overcome the deficiencies of Chan as is discussed further below. Chan discloses that conventional photomasks 20 are formed of a quartz (substrate) layer 2, a Cr opaque layer 4

about 900 Å to 1000 Å thick, an integral CrO antireflective layer 6 of 100 Å thick, and a resist layer 8 of "thicknesses of which are well known in the art" (col. 1, lines 37-51), whereby the Examiner cites the range of 2,000 Å to 10,000 Å taught in Kornblit which, as discussed above, is a difference in kind and not in degree. Chan discloses a photomask 30 of a quartz substrate 2, having a Cr opaque material 4 of 900 Å to 1000 Å thick, a CrO antireflective layer 6 of 100 Å thick, and a hard mask 18 over the CrO layer. The hard mask layer 18 is 50 to 500 Å thick, and is comprised preferably of Si. Chan also recites a shot gun list of other hard mask layers for use in its invention including Ti, TiW, W, TiN, Si_3N_4, SiO_2, or spin-on-glass (i.e., doped SiO_2). (Col. 3, line 63 to col. 4, line 12.)

Chan goes on to disclose that a pattern is formed in a resist material 8 of the blank photomask 30 and transferred to the hard mask material 18 using a first etch process. In its preferred embodiment, Chan discloses that the Si hard mask 18 is etched by Cl_2 gas such that the same chamber can be used to etch the hard mask and the Cr and CRO layers. It discloses that C_2F_6, CHF_3, HBr, Cl_2, or SF_6 plasma gases may etch the Si hardmask as they do not significantly react with the underlying Cr and CrO AR material, such that they expose the Cr and CrO material. (Col. 4, lines 32-56.) Chan teaches that it is a two-step second etching process, namely, of etching the CR and CRO layers that is used to control and overcome the effects of macro loading by controlling the ratio of chlorine to oxygen to retain hard mask material 18 throughout this second etch process. (Col. 4, line 57 to col. 5, line 15.) It does not disclose or contemplate providing for improved achievable

minimum resolution, image quality and critical dimension uniformity of the photomask by providing a resist layer to a thickness ranging from about 1000 Å to 2000 Å over a metal hard mask layer as does the present invention.

Applicant submits that the Chan patent is also a conventional prior art example at which the present invention is aimed at overcoming. Not only does the Chan patent include an additional layer (see, paragraph 0010 of the present specification) between the chrome layer and the hard mask layer, i.e., the CrO antireflective layer 6, as recognized by the Examiner in the above office action, it also is preferred that the hardmask layer comprise Si. (Col. 4, lines 9-11.) In fact, the disclosure of Chan is focused to the teaching that the hard mask layer comprises Si. (*See*, col. 4, lines 11-56.)

As disclosed in the present application, applicant has recognized that in the art of photomask development, quartz substrates impose limitations when used in combination with conventional materials used for hardmasks, such as, SiN, SiO_2, and SiON. These limitations include limitations on the etchant chemistry that can be used to remove the SiN, SiO_2, or SiON hardmask as etchants such as $Cl_2/0_2$ may etch and create defects in the quartz substrate during removal of these SiN, SiO_2, or SiON hardmasks. In addition to the foregoing, these conventional SiN, SiO_2, or SiON hardmasks are "insulators which may lead to charging effects during the electron beam patterning process which, in turn, leads to poor image placement performance." (Specification, paragraph 0050.)

Applicant's invention provides a solution to these insulator hardmasks, such as that disclosed in the Chan patent, by providing a metal hardmask layer directly over a chrome layer to allow for a reduction in the thickness of the resist layer over the metal hardmask layer. (Specification, paragraphs 0051 and 0052.) As recited in the present application, "[t]ungsten, tungsten-silicon, tantalum, tantalum-silicon or copper materials are preferred as they have been found to have no adverse interaction with the resist layer and they are easily removed from the mask without damaging either the remaining chrome or the quartz substrate, unlike other hardmask materials, such as SiO_2, SiON and SiN, which may damage the chrome and/or quartz substrate when removed. Additionally, tungsten, tungsten-silicon, tantalum, tantalum-silicon or copper materials are preferred as they are conducting materials so that charging induced distortions are not present during electron beam exposure as would be the case with SiO_2, SiN and SiON insulating films." (Specification, paragraph 0051.)

It is further submitted that Chan recites a shot gun list of other hard mask layers for use in its invention including Ti, TiW, W, TiN, Si_3N_4, SiO_2, or spin-on-glass (i.e., doped SiO_2) (col. 3, line 63 to col. 4, line 12), however, it does not teach which of these materials, other than Si, is critical to its invention, nor does it teach which of the many possible choices is likely to be successful that would lead one skilled in the art to applicant's invention. Applicant submits that it is established law that obviousness does not exist if the prior art neither indicates which of the disclosed parameters are critical or

gives direction as to which of many choices is likely to be successful. Merck & Co, Inc. v. Biocraft Labs, Inc.(CAFC 1989) 10 USPQ 2nd 1843. Where the prior art gives no indication which parameters are critical and no direction as to which of many possible choices is likely to be successful, the fact that the claimed combination falls within the scope of possible combinations taught therein does not render it as unpatentably obvious. In re O'Farrell (CAFC 1988) 7 USPQ 2nd 1673.

With respect to the Examiner's rejections, it is submitted applicant's invention is not obvious over Kornblit et al. or Chan, whether taken singly or in combination, as both patents represent convention prior art references at which the present invention is aimed at overcoming as discussed above. Moreover, as the Examiner is aware, there is usually an element of "obvious to try" in any research endeavor, since such research is not untaken with complete blindness but with some resemblance of a chance of success. Therefore, "obvious to try" is not a valid test of patentability. *In re Dow Chemical Co. 5 USPQ 2d 1519 (CAFC 1988).* Patentability determinations based thereon as a test are contrary to statute. *In re Antonie 195 USPQ 6 (CCPA 1977).* Arguing that mere routine experimentation was involved overlooks the second sentence of 35 USC 103. *In re Saether 181 USPQ 36 (CCPA 1974).* The issue is whether the experimentation is within the teaching of the prior art. *In re Waymouth et al. 182 USPQ 290 (CCPA 1974).*

Applicant submits that the present invention is not within teachings of the prior art. The present invention would not have been obvious to one of ordinary skill in the art at

the time the invention was made as coating a resist using the ranges suggested by Kornblit 0.2-0.5 micron (2,000 Å to 5,000 Å), which are a difference in kind and not in degree, over the preferred Si hardmask disclosed in Chan would still result in the problems as discussed in the present application at paragraphs 0050 to 0052. Also, adjusting the metal and Cr thickness values as suggested by Chan would not overcome the deficiencies of the Kornblit patent.

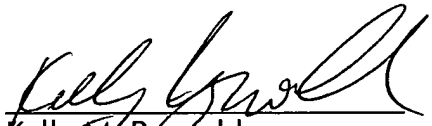
Again, obviousness does not exist if the prior art neither indicates which of the disclosed parameters are critical nor gives direction as to which of many choices is likely to be successful. *Merk & Co., Inc., v. Biocrafts Labs, Inc., 10 USPQ 2d 1843 (CAFC 1989).* Where the prior art gives no indication of which parameters are critical and no direction as to which of many possible choices is likely to be successful, the fact that the claim combination falls within the scope of possible combinations taught therein does not render it unpatentably obvious. In re O'Farrell (CAFC 1988) 7 USPQ 2d 1673. As is also established law, a result not suggested by the prior art can impart patentability to a process whose manipulative steps are within the skill of the art. In re Kaplan (CCPA 1940) 45 USPQ 175.

It is respectfully submitted that both Kornblit et al. and Chan are conventional, broad prior art disclosures of photomasks and merely provide a laundry list where a person skilled in the art must pick and choose from the different materials and thickness ranges disclosed therein, such that, a person skilled in the art could not form Applicant's present

invention without an inventive step. In view of the patent law in this area and the criticality established in the specification, it is respectfully submitted that the claims are properly allowable over both Kornblit et al. and Chan, alone or in combination.

It is respectfully submitted that the application has now been brought into a condition where allowance of the case is proper. Reconsideration and issuance of a Notice of Allowance are respectfully solicited. Should the Examiner not find the claims to be allowable, Applicants' attorney respectfully requests that the Examiner call the undersigned to clarify any issue and/or to place the case in condition for allowance.

Respectfully submitted,



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